

# Effect of tapping tools and date of tapping on *Acacia polyacantha* gum yield in South Kordofan State, Sudan

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**Abstract:** A study was conducted in South Kordofan, Sudan to determine the effect of tapping, tapping tools and date of tapping on the gum yield of *Acacia polyacantha*. A two-factor experiment was conducted for two seasons in 2008–2009. One location was used for two seasons and two locations for one season. The first factor (4 levels) was the tools of tapping: Makmak, Farrar, and Sonki, and the control which was not tapped. The second factor (2 levels) was the date of tapping that comprises mid October and mid November. These treatments were arranged in Randomized Complete Block Design and replicated three times. Gum yield (g/tree and g/picking) was recorded for five pickings. Economic analysis was done using the partial budget technique. The results showed highly significant ( $p < 0.01$ ) differences on gum yield (g/picking and g/tree). The results indicated that the process of tapping increases gum production by 88.4% and 79.8% compared with un-tapped trees, respectively. The date of tapping has no significant effect on gum yield (g/tree and g/picking) of *A. polyacantha*. Tapping of the tree with Makmak in mid- November was found to be economically beneficial compared to using the other tools and the control. These results could identify a new source of income for the poor farmers in South Kordofan mainly because of the wild occurrence of Kakamut as a potential gum producing tree species grown naturally in the area.

**Keywords:** *Acacia polyacantha*; date of tapping; gum yield; Kakamut; South Kordofan; tapping tools

## Introduction

Gum tapping is a traditional way of producing gum in Sudan. Usually the tapping is done for *A. senegal* (gum arabic tree) by using small Axe (Farrar) or by using the developed new hand tool called Sonki (ElKhalifa 1989). The Sonki is driven under the bark of the tree without penetrating the wood between the outer bark and inner cambium (IIED&IES 1989). A strip of bark (30–40 cm) is then removed causing wounds which stimulate gum exudation (Ballal 1991).

The wound resulting from removal of the bark of the tree exposes the inner bark and the cambium of the tree to the external environment (light and wind) and hence the gum exudes cover the wound and thus the *A. polyacantha* gum is formed (Fig. 7). In south Kordofan, *A. polyacantha* gum is collected traditionally from trees without tapping starting from the end of the rainy season and may continue up to the following rainy season.

*A. polyacantha* is ready for tapping after a dormant period following the rainy season. The date of tapping for *A. polyacantha* depends on the end of the rainy season and usually the trees were tapped after shedding their leaves and the change in the tree bark. The first gum exudation takes place a few weeks (45 day) after tapping and favored by hot weather (Ballal 2008).

The wood of the tree is termite-resistant, the hard wood is brown but difficult to work, in many areas; the poles are soaked in mud water for a week before use as a preservative against stem borer. Ash is used in some areas as substitute for salt (Adam 2008). With its strong odor, the root appears to be avoided by animals; it placed among the rafters of the house to repel snakes. In rural areas, the root is placed on crossing areas in the rivers to ward off crocodiles, and also to bathe children who are restless at night (Mhlonishwa 2005). The tree grows by direct seeding, seedling and wilding naturally. It grows well when planted alone or in groups with other trees (Bolza et al. 1972), (Pardy 1951) and (White 1962).

Recently, little attention has been given to the other gum yielding trees such as *Acacia seyal* var *seyal* "Talha", *Boswellia pa-*

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*pyrifera* "Frankincense" and *A. polyacantha* "Kakamut". Therefore, the objective of this study was to study the potentiality of *A. polyacantha* for producing gum and to investigate the effect of different tapping tools and date of tapping on gum yield of *A. polyacantha*.

## Materials and methods

*Acacia polyacantha* subsp. *camphyacantha* (Cutch tree; white thorn; African catechu tree) is known in Sudan as "Kakamut" or "Um sinaina". It belongs to the family Fabaceae "subfamily Mimosoideae". Under favorable conditions, *A. polyacantha* can grow up to 20 m height. Its bark is yellow-brown, flaking; stipules non-spinescent, prickles below nodes in pairs, falcate, 0.4–1.3 cm long, yellow or brown blackish or base yellow, glabrous, leaves 8–27 cm oblong. Inflorescence spicate, 7–11.5 cm long on pubescent peduncles, fruit oblong dehiscent pods 2.5–12 cm brown, glabrous, seeds rhombic to sub circular, 7 mm × 7 mm, brown. The trees usually start flowering in the rainy season (August–September) and fruiting after the end of the rainy season (December–March) (Elamin 1990).

The field experiment was conducted at Umfakarin forest reserve (Latitude 12°05' N, Longitude 31°20' E). The forest is managed by the Forest National Corporation (FNC), and it lies in the gum belt of the Sudan. The soil is loamy sand and clay. The mean annual rainfall varies from 400 to 600 mm. The age of the trees ranged in 5–35 years and the average density ranged in 100–200 trees·ha<sup>-1</sup>. The second location was Lgawa natural forest (Latitude 11°50' N, Longitude 29°11' E). The area of the forest is characterized by a cracking clay soil (Vertisol). The age of the trees was ranged in 10–25 years and the average density was 50–300 trees ha<sup>-1</sup>. The rainy season extended from mid-May to mid-October. The mean annual precipitation in this area ranges in 400–800 mm (Hunting Technical Service 1977).

The experimental design was 2 factorial, randomized complete block design with three replications. The first factor comprises three tools, of tapping namely Makmak, Farrar (traditional tool for tapping *A. senegal*) and Sonki as an improved tapping tool for tapping *A. senegal* developed by the gum research division at El-Obeid Research Station. In addition, the control (without tapping) or the traditional method of production which involves collecting gum from natural exudation by the tree were usually carried out by women in the rural areas of the state (Fig. 1).

The second factor- date of tapping was tested in two levels (15th of Oct. and 15th Nov). Each treatment combination was assigned to 10 trees, making a total of 240 trees for the experiment in each site. The trees were tapped on 15<sup>th</sup> of October and 15<sup>th</sup> of November (Fig. 2). The first gum picking took place 45 day after the tapping, and each consecutive picking was collected after 15 days from harvest of the previous one. The gum from each picking was weighed after drying using a sensitive balance. The economic analysis was done using partial budgeting technique (CIMMYT 1988). The net surplus was obtained by subtracting the total production cost from the gross revenues.

MSTAT-C statistical package (Version 2.10) was used for the

analysis of variance (ANOVA). The analysis was done for the separate location and combined for the whole yield.



**Fig. 1 Tapping tools: Axe<sup>1</sup> (Farrar), Makmak<sup>2</sup> and Sonki<sup>3</sup>**

The first and third one are used for tapping *Acacia senegal* and the second one are used for tapping *Acacia seyal var seyal*.

## Results

The results from the first season 2008 in Umfakarin forest reserve clearly showed that tapping tools show significant differences ( $p < 0.01$ ) in *A. polyacantha* gum yield (g/picking) (Table 1). The highest gum production of 374.48 g/picking was obtained when the trees were tapped by using Makmak tool while the lowest gum production of 31.29 g/picking was recorded from the control. Furthermore, the highest gum yield of (172 g/picking) was obtained in the third pick while, the lowest gum yield of (1 g/picking) was obtained from the fifth pick.

Date of tapping (15th of Oct. and 15th of Nov.) did not show significant differences in gum yield of *A. polyacantha*. Gum yield (g/tree) from Farrar, Sonki, and the control was 13%, 23%, and 87% respectively lower than that obtained from Makmak tapping (Fig. 2).

In the second season 2009 the tapping tools showed significant differences ( $p < 0.01$ ) in gum yield at Umfakarin forest reserve (Table 2). The highest yield of 471.25 g/picking was obtained from Makmak tapping while; the lowest yield of 70.07 g/picking was obtained from the control. Date of tapping did not show significant differences in gum yield. Gum yield (g/tree) obtained from Farrar, Sonki and the control was 55%, 0.05%, and 76% respectively lower than that obtained from Makmak tapping (Fig. 3).

In Lagawa area the tapping tools showed significant effect ( $p < 0.01$ ) in gum yield (Table 3). The highest yield of 386.7 g/picking was obtained when the trees were tapped using the Makmak tool while, the lowest gum yield of 34.15 g/picking was obtained from the control. Date of tapping did not show significant differences in gum yield. Gum yield (g/tree) obtained from Farrar, Sonki and the control was 10.6%, 22.3% and 14.2%, respectively, lower than that obtained from Makmak tapping (Fig. 4).

**Table 1.** Average gum yield of *Acacia polyacantha* (g/picking) as affected by tapping tools and date of at Umfakarin forest reserve, south Kordofan State, Sudan 2008

Tapping tools	<i>Acacia polyacantha</i> gum yield (g/picking)					Total
	First pick	Second pick	Third pick	Fourth pick	Fifth pick	
Makmak	46.93a	40.71a	170.0a	77.79a	39.05a	374.48a
Axe (Farrar)	52.14a	30.08a	172.64a	77.54a	23.46b	355.86a
Sonki	40.14a	40.63a	134.54a	64.96a	14.08c	294.35a
Control	5.58b	4.66b	14.48b	5.52c	1.00d	31.24b
Means	36.19	29.02	122.92	52.45	19.39	263.98
SE±	10.26	5.95	23.35	6.71	3.99	79.44

Date of tapping	<i>Acacia polyacantha</i> gum yield (g/picking)					Total
	First pick	Second pick	Third pick	Fourth pick	Fifth pick	
15 <sup>th</sup> Oct	47.04a	36.72a	125.59a	59.95a	16.73a	208.03a
15 <sup>th</sup> Nov	25.36a	25.36a	120.25a	52.96a	22.07a	241.95a
Means	36.2	29.02	122.92	56.46	19.40	224.99
SE±	7.26	4.21	16.51	4.75	2.83	16.90

\* Treatment means followed by the same letters in the same columns are not significantly different at 5% level

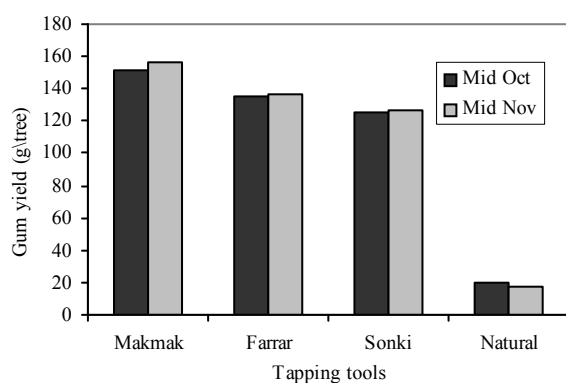
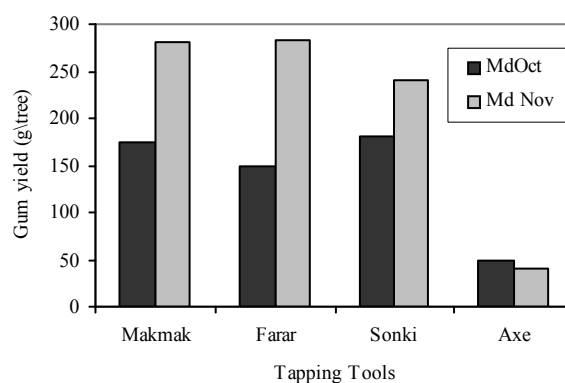
**Table 2.** Average gum yield of *Acacia polyacantha* (g/picking) as affected by tapping tools and date of tapping Umfakarin forest reserve, south Kordofan State, Sudan 2009

Tapping tools	<i>Acacia polyacantha</i> gum yield (g/picking)					Total
	First pick	Second pick	Third pick	Fourth pick	Fifth pick	
Makmak	52.37a	55.98a	274.97a	53.49a	34.44a	471.25a
Axe (Farrar)	43.11a	43.52a	219.9a	54.73a	43.84a	405.1a
Sonki	55.18a	45.24a	232.72a	55.15a	40.11a	428.4a
Control	9.42b	13.85b	24.04b	7.55b	15.21b	70.07b
Means	40.02	39.65	187.91	42.73	33.40	343.71
SE±	7.69	8.27	25.58	4.20	8.35	92.24

Date of tapping	<i>Acacia polyacantha</i> gum yield (g/picking)					Total
	First pick	Second pick	Third pick	Fourth pick	Fifth pick	
15 <sup>th</sup> Oct	38.03a	38.04a	158.89a	25.57a	32.36a	292.89a
15 <sup>th</sup> Nov	42.01a	41.28a	216.92a	59.89a	34.43a	394.53a
Means	40.02	39.66	187.91	42.73	33.40	343.72
SE±	5.44	5.85	18.09	2.97	5.90	50.82

\* Treatment means followed by the same letters in the same columns are not significantly different at 5% level.

**Fig. 2** Effect of date of tapping and tapping tools on *Acacia polyacantha* gum yield at Umfakarin forest reserve in season 2008**Fig. 3** Effect of date of tapping and tapping tools on gum yield of *Acacia polyacantha* at Umfakarin forest reserve in season 2009

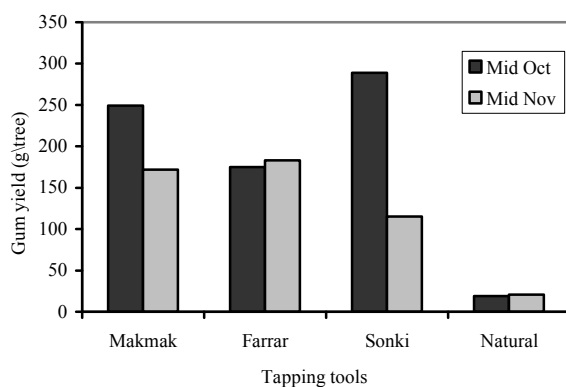
**Table 3. Average gum yield (g/picking) of *Acacia polyacantha* as affected by tapping tools and date of tapping in Lagawa natural forest, south Kordofan State, Sudan 2009**

Tapping tools	<i>Acacia polyacantha</i> gum yield (g/picking)					Total
	First pick	Second pick	Third pick	Fourth pick	Fifth pick	
Makmak	17.67a	26.12a	237.13a	52.29a	53.49a	386.7a
Axe (Farrar)	16.38a	22.58a	186.69b	39.83b	50.46a	315.94a
Sonki	45.42b	12.71b	159.14b	23.00c	32.07b	272.34a
Control	4.38c	5.33c	16.19c	4.63d	3.62c	34.15b
Means	20.96	16.69	149.79	29.94	34.91	252.29
SE±	7.48	2.11	20.80	4.93	3.17	76.43

Date of tapping	<i>Acacia polyacantha</i> gum yield (g/picking)					Total
	First pick	Second pick	Third pick	Fourth pick	Fifth pick	
15 <sup>th</sup> Oct	23.36a	16.60a	158.53a	33.86a	28.45a	260.8a
15 <sup>th</sup> Nov	18.54a	16.77a	141.05a	26.01a	41.38a	243.75a
Means	20.95	16.89	149.79	29.94	34.92	252.28
SE±	5.28	1.49	14.71	3.49	2.24	8.53

\* Treatment means followed by the same letters in the same columns are not significantly different at 5% level

**Fig. 4 Average gum yield (g/tree) of *Acacia polyacantha* as affected by date of tapping and tapping tools in Lagawa natural forest in 2009**

The results of gum yield in the two seasons 2008 and 2009 are presented in (Table 4) which gave significant differences ( $p < 0.05$ ) on the gum yield (g/picking and g/tree) for interaction between date of tapping and tapping tools; however, the yield obtained from tapping trees was higher than that from the control through the two date of tapping. Only the gum yield (g/tree) was affected by interaction between the two factors (date of tapping and tapping tools) from the other hand still the differences on gum yield even g/picking or g/tree was highly significantly affected by tapping tools (Table 5). Tapping *A. Polyacantha* tree increase gum yields by 88.4% compared to the control Also in the combine over locations. The mean gum yield was also increase by 75.8% due to tapping (Fig. 5).

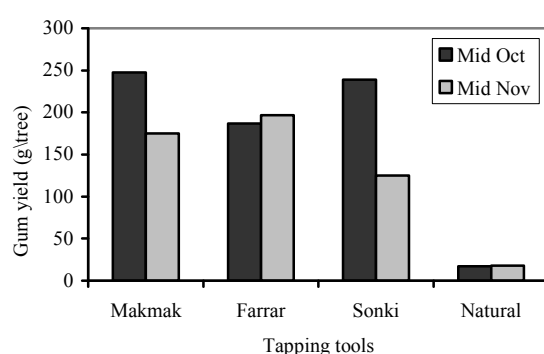
**Table 4. Average gum yield (g/picking and g/tree) of *Acacia polyacantha* gum yield (g/picking and g/tree) as affected by tapping tools and date of tapping in south Kordofan State, Sudan (combine of two seasons 2008/2009)**

Date of tapping	Tapping tools				Mean	SE±
	Makmak	Farrar	Sonki	Natural		
Mean yield (g\picking) season 2008						
Mid Oct.	39.39a	31.06a	33.47a	3.97a	26.97	1.14*
Mid Nov.	33.13a	32.91a	22.63a	3.51a	23.04	2.27*
Mean	36.26	31.98	28.05	3.74	25.01	
SE±	3.13	0.93	5.42	0.23		
Mean yield (g\tree) season 2009						
Mid Oct.	196.93	155.29	167.35	19.45	134.85	5.67*
Mid Nov.	165.62	164.53	113.15	17.15	115.21	11.35*
Mean	181.28	159.91	140.25	18.69	125.03	
SE±	15.66	4.65	27.10	1.15		

\* Treatment means followed by the same letters in the same columns are not significantly different at 5% level

**Table 5.** Average *Acacia polyacantha* gum yield (g/picking and g/tree) in relation to tapping tools and date of tapping in south Kordofan State, Sudan

Date of tapping	Tapping tools				Mean	SE±
	Makmak	Farrar	Sonki	Natural		
Mean yield (g/picking)						
Mid Oct.	32.2	27.68	30.07	7.57	24.38	1.24*
Mid Nov.	38.61	36.81	33.68	5.87	28.74	2.48ns
Mean	35.40	32.25	31.87	6.72	26.56	
SE±	3.21	4.57	1.81	0.85		
Mean yield (g/tree)						
Mid Oct.	160.98	138.41	150.33	37.82	121.89	6.21*
Mid Nov.	193.06	184.05	168.37	29.36	143.71	12.42ns
Mean	177.02	161.23	159.35	33.59	132.8	
SE±	16.04	22.85	9.05	4.2		

**Fig. 5** Average *Acacia polyacantha* gum yield (g/tree) as affected by date of tapping and tapping tools combined over season and locations

The different tapping tools were economically evaluated by using the partial budgeting technique. Makmak tapping recorded the highest net benefit (57 SDG/ha) compared with the other tools (Farrar and Sonki). The net benefit of using Makmak exceeded the Sonki by 57% (Table 6).

**Table 6.** Partial budget (SDG/ha) for the different tapping tools used for tapping *Acacia polyacantha* trees for gum production in south Kordofan State, Sudan

Tapping tools	Gum yield kg/ha	Gross benefit SDG/ha	Net benefit SDG/ha
Makmak	435.07	87.02	57.00
Farrar	383.78	76.76	46.76
Sonki	336.60	67.32	36.32
Natural	44.86	8.97	-21.03

1 US\$= 2.4 SDG

The partial budget analysis for evaluating different tools of tapping in two dates of tapping (mid Oct and mid Nov) is summarized in (Table 7). In the two date of tapping the highest net benefit was recorded for using Makmak, while the lowest net benefit at (14.31 SDG/ha) was recorded for using Sonki. Tapping of the trees in 15th of October gave the highest net benefit by using different tapping tools compared with tapping in Mid No-

vember. This result indicated that mid October was economically the best date of tapping Kakamut tree for gum production by using Makmak. Also the economic results showed that tapping of Kakamut produced highly gum in comparison with not tapping. This result also indicated that Makmak was the best tool for tapping Kakamut tree for gum production.

**Table 7.** Partial budget (SDG/ha) for the different tapping tools and date of tapping for *Acacia polyacantha* gum production in south Kordofan State, Sudan

Tapping tools	Yield (kg/ha)		Gross benefit (SDG/ha)		Net benefit (SDG/ha)	
	Mid	Mid	Mid	Mid	Mid	Mid
	Oct.	Nov.	Oct.	Nov.	Oct.	Nov.
Makmak	472.63	397.49	94.53	79.49	64.53	49
Farrar	372.63	394.87	74.54	78.97	44.54	48.97
Sonki	401.64	271.56	80.32	54.31	50.32	14.31
Natural	46.68	41.16	9.34	8.23	-20.66	-21.76

1 US\$= 2.4 SDG

## Discussion

In the present investigation, the highest gum yield was obtained from the using of Makmak for tapping *A. polyacantha* tree. The reason can be seen in the wide edge on the top of the tool (Fig 1), which allows one to remove a big piece of the bark. However, due to difference in the bark of *A. senegal* and *A. polyacantha*, the Sonki and the Axe were less suitable for tapping *A. polyacantha*. Fadl and Geabauer (2004) reported that tapping of the *Acacia seyal* var *seyal* tree by the Makmak tool increased gum yield compared with that using the Axe, Mohfar and Sonki. Similar result was obtained by Abass et al. (2009) when investigated the effect of Sonki and Mengaf on *Boswellia papyrifera* gum tree. They concluded that tapping of the tree using Mengaf tool gave a total yield nearly twice that for the Sonki tool.

The date of tapping in this study did not show significant effect on *A. polyacantha* gum yield. However, the 15<sup>th</sup> of October date of tapping show slight increase in gum yield. This result is

in agreement with the finding of Fadl and Gebauer (2006). They investigate the effect of date of tapping and tapping intensity on the gum yield of *Acacia seyal* var *seyal* and found that the date of tapping had a significant effect on the amount of gum production.

It was observed that within this experiment there was a considerable variation in the gum yield from pick to pick and from tree to tree. This variation may attribute to the variation on the climatic factors and the management practices. This result is in agreement with finding of Ballal (1991). He attributed the variation in *A. senegal* gum yield to the variation in the climatic factors and management practices. Also Fanshawe (1962) and Ballal (2008) attributed the differences in the gum yield to the differences in the amount of rainfall and probably to the management practices.

The present investigation are the first record on tapping *A. polyacantha* subsp *campylacantha* and well serve as an impetus for further research in the extraction of kakamut gum.

## Conclusions and Recommendations

Tapping the *A. polyacantha* tree by using the (Makmak, Axe (Farrar) and Sonki) increased the gum yield. In our experiment the use of the different tapping tools indicated that Makmak was the better tool for tapping *A. polyacantha* tree, and it is wide blade allows one to remove a bigger piece of the bark compared with the Axe (Farrar), Sonki and untapped trees. Date of tapping did not show significant differences. However, tapping the trees on 15<sup>th</sup> of October gave a higher yield than on 15<sup>th</sup> of November. Gum production from tapping *A. polyacantha* tree can provide additional house hold income especially during the dry season. To increase *A. polyacantha* gum yield tree should be tapped to improve gum exudation rather than relying on naturally exuded gum and the Makmak tool should be used in Mid November to increase the gum yield compared to other tapping tools or dates of tapping.

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